Reform of the National Security Science and Technology Enterprise

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Introduction

A strong science and technology (S&T) program has been vitally important to American national security since World War II and has to date given the United States a strategic advantage over competitors. During World War II and throughout the Cold War, highly specific and large-scale technology needs led to the concentration of national security S&T (NSST) programs in a few agencies, with little cross-agency coordination. Since the end of the Cold War, circumstances have changed greatly. Meeting new and emerging threats to national security—from global climate change to the proliferation of weapons of mass destruction and global terrorism—requires an effective mechanism for direction, funding, and integration of the highly fragmented and very wide range of Federally-supported S&T.

Science and technology underlie the elements of national power (diplomacy, intelligence, military, economics), but they are only rarely named as elements of national power, and the priorities, policies, and personnel for S&T are often neglected. Specific S&T capabilities have been particularly isolated in direct applications to traditional security capabilities, and fragmented even more in addressing the new and broad challenges to our security. Thus, the structure and integration of S&T in the Executive Branch agencies, integration of congressional S&T committees, and the roles and responsibilities of Government scientists and engineers, are key issues that must be considered when evaluating how we can significantly improve our nation's security.

With the onset of World War II, President Franklin Roosevelt, convinced of the importance of S&T to winning the war effort, created the wartime Office of Scientific Research and Development (OSRD) in 1941. Led by the visionary Vannevar Bush, the goal of the OSRD was to develop a strategic enterprise for national research supporting the military. The OSRD was responsible for funding the development of such war-winning technologies as radar, radar countermeasures, anti-submarine warfare, the proximity fuze, amphibious vehicles, mine detectors, flame throwers, the bazooka, sea-launched rocket artillery, TV-guided bombs, torpedo improvements, smoke generators, and the atomic bomb.[1] Thus, at the end of World War II, when the current organizational structures for national security were established and began to evolve, science and technology were perceived to play a central role in providing security.

Vannevar Bush led the creation of a philosophy and model for strategic management of the country's S&T enterprise, which today consists of many Federal departments and agencies that have core missions supporting S&T, such as the National Science Foundation (NSF) and the Department of Commerce's National Institute of Standards and Technology (NIST). Congress supported the development of this infrastructure with substantial funding and the creation of specific committee jurisdictions for S&T.

[1] University of San Diego History Department, "Office of Scientific Research and Development," available at <http://history.sandiego.edu/GEN/WW2Timeline/OSRD.html>.

A second major period of reorganization for S&T came immediately after the launch of Sputnik. In 1957, President Dwight Eisenhower appointed the first formal science advisor to the President, when he named James R. Killian, Jr. of the Massachusetts Institute of Technology as Special Assistant to the President for Science and Technology.[2] In 1958, both the National Aeronautics and Space Administration (NASA) and the Defense Advanced Research Projects Agency (DARPA) were created in the Executive Branch, and Congress created the House Science Committee to manage civilian research and development (R&D).[3]

More recently, the House Science committee pushed through legislation in 2002 to create an undersecretary-level Science and Technology advisor for the Department of Homeland Security, despite considerable opposition from the Administration.

Because of the expansion of the Executive Branch into many non-defense areas needing S&T, there are now over 29 Federal agencies involved in supporting over $100 billion per year in Federal R&D.

The number of Federal agencies that fund science or technology is large, and the number of vehicles for performing R&D increases the complexity of the overall enterprise. Agencies can fund research through universities, Government agency laboratories, Federally funded research and development centers (FFRDCs), and private companies.[4] One consequence of increased complexity is increased difficulty moving expertise, resources, and knowledge across organizational boundaries.

What has traditionally been thought of as NSST has been funded mostly by the Department of Defense, the Department of Energy (for nuclear weapons) and, more recently, by the Department of Homeland Security. This R&D has been conducted by the Service laboratories, 36 FFRDCs,[5] industry, and universities. With the rise of new challenges to our national security, many agencies that once were not central to national security are becoming much more important, e.g., the Department of Agriculture and National Institutes of Health, both of which now address bioterrorism.

The nature of national security has changed since the Cold War. The principal focus of national security strategy during the Cold War (major combat operations and nuclear deterrence) led to limited coordination between vertically structured departments and

[2] MIT News Office, "Eight of 18 Presidential Advisors on Science have MIT Ties," May 1, 2001, available at <http://web.mit.edu/newsoffice/2001/ostpside.html>.

[3] The terms *S&T* and *R&D* often are used interchangeably. However, within DOD, S&T refers to the budget categories 6.1–6.3, which are basic research, applied research, and advanced technology development; R&D refers to budget categories 6.1–6.7, which also include testing, evaluation, and design of final products. While this paper deals mainly with S&T, and specifically NSST, S&T must always be considered in the broader context of R&D. S&T is often considered the R of R&D.

[4] Procurement can also be used to stimulate innovation. See Richard R. Nelson and Richard N. Langlois, "Industrial Innovation Policy: Lessons from American History," *Science* 219, February 18, 1983, 814.

[5] The National Science Foundation list of FFRDCs is available at <http://www.nsf.gov/statistics/nsf05306/>.

agencies,[6] and national security S&T became "stovepiped" to serve the requirements of departments and agencies that funded it. Stovepiping created structural, organizational, and legal impediments to providing direction, funding, and access to S&T capabilities across traditional national security agencies, and even more difficulty in coordinating or accessing all Federal S&T that could apply to new security challenges. In the new security environment, S&T will be even more important to anticipating threats, developing innovative technologies to meet those threats, and informing the national security debate.

The discussion above leads to three major topics requiring new thinking. The first topic is how overarching priorities can be better determined and implemented to direct the vast national security enterprise toward conducting S&T that will address both traditional and new national security challenges. This is a primary role of the Science Advisor to the President and the Office of Science and Technology Policy (OSTP). The second topic deals with the integration of the Congressional committees that oversee and fund S&T. The third topic focuses on the competence, role, and impact of the Government's national security S&E workforce. This paper addresses these topics and recommends measures to improve our NSST posture.

[6] James R. Locher III, "The Most Important Thing: Legislative Reform of the National Security System," *Military Review*, May-June 2008, 4–12.

Executive Branch Reform for S&T

Meeting the growing security challenges of the 21st century will be a vast undertaking for the next administration. Since the end of the Cold War in 1991, diverse challenges have emerged to threaten U.S. national security, from an increase in the number of global powers and non-state actors, to environmental degradation and climate change, to the global diffusion of cutting-edge and innovative technologies.

> Science and technology are being rewritten in atomic, digital and genetic codes, with game-changing innovation rising from the digital, biotechnology and nanotechnology revolutions. Leadership at the frontier of science and technology conveys competitive advantage in the global economy, particularly to those poised to rapidly translate new knowledge and insight into new high-value products and services. Such leadership also will be critical in answering many of the global grand challenges: global warming, global hunger and global disease, to name only a few of the pressing problems that confront the world's citizens.[7]

Unquestionably, science and technology are critical enablers of national security and thus must play an important role in national security policy and decisionmaking. Strong S&T leadership, coupled with strategic S&T guidance to inform national security policymaking and resource allocation, will improve the U.S. Government's ability to effectively provide for the Nation's security in the 21st century.

Three key issue areas in NSST that should be strengthened to meet the expanding security challenges of the 21st century include: the slow appointment process for key Executive Branch S&T positions, the limited power and authority of OSTP, and the lack of overarching guidance on NSST priorities. Strengthening Executive Branch S&T policymaking and execution will allow the Federal Government to better contribute to, access, and utilize the Nation's S&T capabilities.

Slow Appointment Process for Key Science and Technology Positions

The importance of strong S&T advisory resources cannot be overstated. As an authoritative study observed:

> Recent decades have seen a steady increase in the number and complexity of issues coming before the President. These issues arise from increases in scientific knowledge and technological development, their application in society, and increased understanding of their impact on society. Resolution of such issues requires S&T expertise and balanced judgment.[8]

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[7] Council on Competitiveness, "Five for the Future," Proceedings of 2007 Annual Meeting, October 26, 2007, 17, available at <http://www.compete.org/images/uploads /File/PDF%2 0Files/ Five_ Final_ 8858COC.pdf>.

[8] Committee on Science, Engineering, and Public Policy, National Academy of Sciences, National Academy of Engineering, Institute of Medicine, *Science and Technology in the National Interest: The Presidential Appointment Process* (Washington, DC: National Academies Press, 2000), 3.

With new threats emerging daily, the President will need a robust network of S&T expertise at the beginning of the new administration to advise on key issues that will affect both U.S. and international security. Unfortunately, the S&T advisory process in the past has been stymied by bureaucratic and political issues, often resulting in a slow appointment process for key S&T positions in the Federal Government.

A series of actions should be taken to ensure that the President has the capability to address issues of national security importance at the outset of the new administration.[9] First, in advance of the election, each of the presidential candidates should appoint advisors with S&T expertise to the transition team. These individuals will provide invaluable advice on issues that will affect the President and the American homeland. At this time, the President-elect should identify top candidates for the positions of Science Advisor to the President and Director of the Office of Science and Technology Policy.

Soon after the election, the President will need to identify and appoint a Science Advisor. As a former Science Advisor has observed:

> Much of the effectiveness of the Science Advisor depends on the personal relationship between the Advisor and the President. It is also absolutely true that the President needs to appoint an advisor as soon as possible. If the science Advisor is not appointed early in the game, then the other 11 Assistants to the President close in, pull the wagons together, and the Science Advisor has to waste considerable time working his or her way into the system.[10]

This individual, who serves as a personal adviser and does not require Senate confirmation, is extremely important to the national security process. He or she will be required to help set security and policy priorities and plan strategy for the new Administration.[11] Further, that person will be highly valuable in advising the President on qualified candidates for key Federal S&T positions.[12] Early appointment also is of utmost importance if the Science Advisor is to develop a strong interagency team of S&T executives who work on common goals for national security.

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[9] The Study Group on Presidential Science and Technology Personnel and Advisory Assets at the Center for the Study of the Presidency recently published a report that makes a number of key recommendations on NSST. The report, titled "Presidential Leadership to Ensure Science and Technology in the Service of National Needs: A Report to the 2008 Candidates," can be found at <http://www.thepresidency.org/pubs/science_tech_2008.pdf>. A report by the Woodrow Wilson Center also provides recommendations on activities that should be undertaken by the next Administration to strengthen OSTP. The report, "OSTP 2.0 Critical Upgrade Enhanced Capacity for White House Science and Technology Policymaking: Recommendations for the Next President," can be found at <http://www.wilsoncenter.org/ news/docs/OSTP%20Paper1.pdf>.

[10] Allan Bromley, "Advancing Innovation: Improving the S&T Advisory Structure and Policy Process," The Center for the Study of the Presidency, 2000, 13–14, available at <http://www.thepresidency.org/pubs/AdvancingInnovation.pdf>.

[11] Committee on Science, Engineering, and Public Policy, National Academy of Sciences, National Academy of Engineering, Institute of Medicine, *Science and Technology in the National Interest: The Presidential Appointment Process* (Washington, DC: National Academy Press, 2000), 2.

[12] Ibid.

The President and his team should also begin the appointment process to fill the position of Director of OSTP very early on in the administration. This is a Senate-confirmed position. In many administrations, the Science Advisor to the President has also served as the Director of OSTP. Early appointment of the Director of OSTP is critical to ensuring that OSTP has the opportunity to shape and set important NSST priorities across the agencies and establish strong working relationships with other White House policymaking offices.

The next administration, working with the Senate, should also accelerate the selection and approval process for all other nominees in senior S&T positions, e.g., the Department of Commerce Under Secretary for Technology, the Department of Defense Director of Defense Research and Engineering, the Department of Energy Under Secretary for Science, and the Department of Homeland Security Under Secretary for Science and Technology. History amply demonstrates the difficulty of recruiting highly-qualified professionals for senior Government S&T positions. As discussed in a National Academy report, such factors as a long nomination and Senate confirmation process, detailed requirements for public financial disclosure, and the high costs of moving to and living in Washington, DC, have resulted in long delays filling key S&T positions.[13] Failure to identify candidates and accelerate the selection and approval process for senior S&T executive positions would "lead to the Government's inability to make key decisions in the face of rapid scientific and technological change, as well as the ability to design, carry out, and evaluate effective and responsive programs."[14]

A recent National Academy Report proposes a number of important actions, such as the early selection and appointment of key individuals, in particular the Science Advisor to the President. The report also recommends streamlining and accelerating the nomination for key S&T individuals, reducing the personal and financial burdens on nominees for these positions, and clarifying and standardizing pre-employment and post-employment restrictions. The report also recommends that science, engineering, academic, and health societies should propose emerging leaders in their fields to expand the pool of qualified candidates for senior S&T leadership positions and that "[t]hePresident should ensure that his administration makes the process for nominating and appointing people to advisory committees explicit and transparent."[15]

Limited Power and Authority of OSTP

Established by Congress in 1976, OSTP is charged with a broad mandate to advise the President and the Executive Office of the President on the effects of science and

[13] Panel on Presidentially Appointed Scientists and Engineers, Committee on Science, Engineering, and Public Policy, National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, *Science and Technology Leadership in American Government: Ensuring the Best Presidential Appointments* (Washington, DC: National Academies Press, 1992), 3–4.
[14] Ibid., 5.
[15] National Academy of Engineering, and Institute of Medicine, Committee on Science and Technology in the National Interest, "*Science and Technology for America's Progress: Ensuring the Best Presidential Appointments in the New Administration,"* September 2008, 3, available at <http://books.nap.edu/catalog.php?record_id=12481#toc>.

technology in areas of national and international security concern. The 1976 Act (public law 94-282) designated the responsibilities of a Director and four Associate Director positions and authorized OSTP to lead interagency efforts to develop and implement S&T policies and budgets. It also tasked OSTP with working with and building partnerships with the private sector, state and local governments, the scientific and educational communities, and other governments.[16]

While the goals and mandates of OSTP are commendable, the organization has suffered from limited power and authority.

> The OSTP is a relatively small outfit of about 60 specialist staff whose job it is to prepare advice for the president and coordinate science policy across the federal government. It was thrust on an unwilling White House by Congress in 1976 and has struggled ever since to exercise real clout.[17]

Some experts have argued that the organization is not only understaffed, but also has limited input in the S&T budget process and the development of national S&T research priorities,[18] resulting in a lack of coordination and communication among different agencies and a duplication of effort in key S&T priority areas. Others have argued that OSTP would benefit from more formal relationships with the National Security Council (NSC), the National Economic Council (NEC), and the Homeland Security Council (HSC), which would allow OSTP to have more of a role in national S&T policy formulation.

To maximize OSTP's ability to lead interagency efforts to develop, coordinate, and implement S&T policies and budgets, a number of actions should be undertaken. First, the number of OSTP professional staff should be increased so that the office can better handle all of the "regulatory, fiscal, legal and business environment policies that impact the innovation process."[19] This would allow OSTP to be more proactive and plan S&T policy priorities and goals, rather than react to crises and events as they happen. Second, fill the four Presidentially appointed Associate Director positions early on with leading candidates drawn from different scientific and technical fields. The Carnegie Commission on Science, Technology, and Government has argued that these posts should be used to reinforce the policy functions of OSTP and to "improve the coupling between OSTP and the various offices and councils in the Executive Office of the President."[20] According to former Science Advisor Allan Bromley, the importance of filling all four positions cannot be understated:

> In today's world of S&T, no person can be expected to have experience and background in more than a limited number of areas. Five properly selected brains

[16] Office of Science and Technology Policy, "Department Organization," 2008, available at <http://www.ostp.gov/cs/about_ostp>.
[17] Geoff Brumfiel, "U.S. science policy: Mission impossible?," *Nature*, 428, no. 6980, March 18, 2004, 250–251.
[18] Center for the Study of the Presidency, "Advancing Innovation: Improving the S&T Advisory Structure and Policy Process," 2000, available at <http://www.thepresidency.org/pubs/AdvancingInnovation.pdf>.
[19] Ibid.
[20] Carnegie Commission on Science, Technology, and Government, "Science, Technology, and the President," October 1988, available at <http://www.carnegie.org/sub/pubs/science_tech/pres.txt>.

> are obviously better than one, and regular daily meetings among them provide essential breadth of action. Regular meetings of the OSTP Director and the four Associate Directors, entirely out of Washington, similarly allowed renewed focus on the long-term program and goals of the President that all too frequently get lost in the welter of daily demands on OSTP. I consider that reduction in this statutory number of four Associate Directors in OSTP as a very serious mistake.[21]

It has often been the case that not all four Associate Director positions have been filled. This is the case under the current administration—the position of Associate Director for Homeland and National Security remains unfilled.

To increase OSTP's stature and ability to set S&T priorities and goals, "serious consideration should be given to joint arrangements whereby one Associate Director would work part-time with the NSC staff."[22] While OSTP staff have worked closely with the NSC and other components of the Executive Office, a more formal relationship is needed with the NSC, as well as the HSC and the NEC. Also important to OSTP's ability to set research priorities would be a strong working relationship with the Office of Management and Budget (OMB). In the past, OSTP has been hampered in setting S&T goals and priorities because of its weak relationship with OMB and limited ability to influence the budget.

> In total, the Balkanization of influence over S&T budgeting in the federal government precludes any strategic approach to priority setting and funding allocations. While a "Research and Development" budget can be—and is—constructed each year, this budget is an after-the-fact summation of numerous, independent actions taken by Congressional committees and Executive branch bodies.[23]

Lack of Strategic Guidance on S&T Priorities

The function of strategic guidance on priorities is conspicuously absent from the roles of OSTP and the Science Advisor and the conduct of Federal NSST. The annual letter of broad Administration R&D priorities signed by the directors of OSTP and OMB[24] for the past 5 years does not provide sufficient direction and focus for NSST.

Within the current NSST system, priority setting and oversight of the agencies' S&T activities are limited, resulting in agencies pursuing their own S&T objectives. This has resulted in harm due to unproductive duplication of effort and inefficient use of NSST

[21] Allan D. Bromley, "Invitee Comments: D. Allan Bromley," October 16, 2002, available at <http://phe.rockefeller.edu/ccstg+10/bromley.html>.
[22] Carnegie Commission on Science, Technology, and Government. "Science, Technology, and the President," October 1988, available at <http://www.carnegie.org/sub/pubs/science_tech/pres.txt>.
[23] Daniel Sarewitz, "Does Policy Exist, and If So, Does it Matter?: Some Observations on the U.S. R&D Budget," April 8, 2003, Discussion Paper for Earth Institute Science, Technology, and Global Development Seminar, 3, available at <http://www.cspo.org/products/papers/budget_seminar.pdf>.
[24] A copy of the "FY 2009 Research and Development Budget Priorities" is available at <http://www.ostp.gov/galleries/Budget09/FY2009FINALOMB-OSTPRDPrirityMemo.pdf>.

resources. Illustrative of this is the issue of biodefense in the United States. As Cindy Williams and Gordon Adams have observed*:*

> As with other security missions that cut across the federal government, weak organizations, processes, and tools for planning and resource allocation are keeping the nation from getting its money's worth in this area. Top-down, mission-oriented planning is weak, both within and across departments. As a result, agencies are duplicating each others' efforts in research and development, intelligence, surveillance, and infrastructure.[25]

The Science Advisor, in collaboration with OSTP, should develop a set of guidelines on priority NSST research. This will act to increase coordination and communication among the S&T departments and agencies and decrease bureaucratic stovepiping and, more importantly, duplication of effort in key S&T priority areas. These guidelines should have Presidential support and should be used to set budget priorities.

To further promote the development of Federal NSST priorities, an NSST strategy could be developed. In 1995, for example, the Clinton administration released an NSST strategy that discussed the importance of S&T in national security and in meeting the administration's three primary national security objectives: enhancing military readiness and capabilities, preventing conflict from occurring through engagement with other nations, and promoting prosperity at home.[26] The next administration should similarly adopt a strategy to assist in setting guidelines on priority NSST research areas. This would not only guide the research done by the agencies, but also assist in setting budget priorities government-wide and creating more unity of effort in NSST.

The Science Advisor co-chairs the President's Council of Advisors on Science and Technology (PCAST) and the National Science and Technology Council (NSTC). Established by executive order on November 23, 1993, the NSTC is a cabinet-level council and the principal means within the Executive Branch to coordinate Federal S&T policy.[27] The work of the NSTC is organized under four committees: Science, Technology, Environment and Natural Resources, and Homeland and National Security. What is important about the NSTC is that all departments and agencies, whether or not represented on the council, are supposed to coordinate S&T policy through the council and share information and R&D budget requests with the council.[28]

Because the NSTC is chaired by the President, it is necessary to have Presidential interest and support if the NSTC is to be effective in influencing departments and agencies and

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[25] Cindy Williams and Gordon Adams, *Strengthening Statecraft and Security: Reforming U.S. Planning and Resource Allocation*, June 2008, available at <http://www.stimson.org/budgeting/publications/MIT%20mongraph%20Williams-Adams%20final%207.08.pdf>.

[26] The White House, "National Security Science and Technology Strategy," 1995, available at <http://clinton4.nara.gov/WH/EOP/OSTP/nssts/html/nssts.html>.

[27] National Science and Technology Council, "About NSTC," 2008, available at <http://www.ostp.gov/cs/nstc/about>.

[28] The White House, Executive Order 12881 of November 23, 1993, Establishment of the National Science and Technology Council, November 23, 1993, available at <http://www.ostp.gov/cs/nstc/executive_order>.

achieving maximum participation by NSTC members. It is also extremely important that NSTC committees focus research efforts on S&T research priorities chosen by the Science Advisor and OSTP in order to avoid nonessential duplication of effort and ensure that the S&T capabilities within the departments and agencies are maximized for NSST priorities.

PCAST was established to enable the President to receive advice from the private sector and the academic community on technology, scientific research priorities, and math and science education.[29] On September 28, 2007, President Bush signed an executive order extending PCAST until September 30, 2009. To maximize the role of PCAST, the next President, on advice from the Science Advisor and OSTP, should task PCAST early on in the administration with select NSST research priorities on which industry and academia can focus efforts and provide expert advice. As stated by William Wells, a former OSTP chief of staff:

> PCAST should not be all over the map. It has to focus on a half-dozen or so issues, period, if it is going to help the President. And early in an Administration OSTP and PCAST have to agree on what those half-dozen key issues are going to be.[30]

Strong S&T leadership, coupled with strategic S&T guidance to direct U.S. national security policymaking and resource allocation, will increase coordination and communication among the S&T agencies. Accelerating the selection and approval process for senior S&T positions, increasing the authority of OSTP, and providing overarching guidance on NSST priorities will improve the U.S. Government's ability to effectively provide for the nation's security in the 21st century.[31]

[29] President's Council of Advisors on Science and Technology, "About PCAST," 2008, available at <http://www.ostp.gov/cs/pcast/about>.

[30] Center for the Study of the Presidency, "Advancing Innovation: Improving the S&T Advisory Structure and Policy Process," 2000, 17, available at <http://www.thepresidency.org/pubs/AdvancingInnovation.pdf>.

[31] Another issue deals with the structure and organization for managing NSST within the Executive Branch. There is need for a detailed study of new organizational constructs for NSST, including Vannevar Bush's original proposal for a single organization to manage all NSST.

Congressional Role in NSST

Congress plays a critical role in the oversight of R&D and NSST by setting strategic goals through legislation, creating executive organizations or programs, exercising oversight of executive agencies, approving budgets, and handling specific issues of high political or policy importance. However, Congressional activities are typically much less well understood by observers and the general public than are the activities of the Executive Branch, which are generally the focus of public policy debates. Hence, problems that arise in the oversight of NSST by Congress often do not receive the attention they deserve from analysts and national security professionals.

The role of Congress in overseeing NSST is complex, difficult, and not extensively documented. However, recent major policy studies have made concrete and informed recommendations for improving Congressional activities. Interviews with former Members of Congress and staff, as well as S&T policy experts, have also informed the recommendations that follow.

Management of the U.S. S&T portfolio in general is rarely given the attention it deserves, particularly by Congress, even though that portfolio is identified as a critical enabler of national security, economic growth, and the competitiveness of the American workforce. The Federal investment in S&T is enormous, both in dollars and as a fraction of the U.S. Federal discretionary budget. Inadequate attention to NSST priorities by the Federal Government not only wastes resources, but creates many unintended consequences, e.g., the proliferation of budget earmarking by Congress. Four core problems and recommended solutions to those problems are discussed in this section: the internal structure of Congress, the interface of Congress with the Executive Branch on NSST priorities, setting budgets, and expert advice to Congress on NSST.

Brief History of Congressional S&T Oversight

Most of the detailed management of Federal S&T activities today occurs in the Executive Branch. This is largely a post-World War II phenomenon. Early in our country's history, Congress took an active role in crafting long-term technology strategies as well as specific programs and budgetary allocations.[32] In 1790, for example, Congress passed its first science and technology policy-related act regarding patents, which eventually led to the creation of the Patent and Trademark Office.[33]

As is often pointed out, the authors of our Constitution expressed their view of the importance of technology in the growth of our country by including specific provisions, such as the right to hold patents. In the 19th century, Congress passed the Morrill Act,

[32] A brief history of U.S. Congressional initiatives for S&T is contained in CRS Report RL34453, Deborah D. Stine, "Science and Technology Policymaking: a Primer," April 22, 2008, available at <http://assets.opencrs.com/rpts/RL34454_20080422.pdf>.
[33] Ibid.

creating our system of State universities to advance technology and agriculture as a basis for accelerating economic growth, as well as developing "military tactics." The greatest growth in Federal S&T infrastructure during that period occurred during and after the Civil War, with research becoming one of the core missions of the U.S. military. Congressional activities included establishing the Weather Bureau, funding the Naval Observatory, supporting several polar explorations, and creating the National Academy of Sciences, an independent body tasked with providing objective S&T advice to Congress. This fledgling S&T infrastructure for the first time raised the question of how research should best be managed by Congress. The initial response was the creation in 1884 of a Joint Commission composed of three members each of the Senate and House, who debated many fundamental science policy issues that are still relevant today. This committee, however, had no specific oversight and budget authority and remained a largely advisory body.

As noted earlier, the Federal role in S&T was transformed by World War II, with the creation of the Office of Scientific Research and Development under Vannevar Bush and its evolution to the vast Federal S&T enterprise of today. With the expansion of the bureaucratic structure for S&T, the center of gravity for expertise, policy, and budget shifted heavily to the Executive Branch. Distribution of the oversight and budgetary jurisdictions for Congressional committees has become increasingly complex and fragmented. A relatively small proportion of Members of Congress have technical backgrounds, and fewer still are champions for S&T issues. Another important factor is the difference in size of the two branches of Government. For example, while the Executive Branch employs tens of thousands of people to manage research activities, Congressional committees sometimes have only a handful of staff, often without a technical background, tasked with S&T-related duties.

What is clear is that S&T, and R&D in general, are grossly under-represented in the Congress in proportion to their importance in national security affairs. The total Federal budget for R&D in FY 2009 is proposed to be $147.4 billion.[34] The R&D budget of the Defense Department alone exceeds $80 billion—over 54 percent of all Federal R&D—and other national security R&D is conducted by the intelligence community and the Department of Energy. This large segment of the Federal discretionary budget is critically important to developing national security capabilities, economic growth, public health, and education of the American workforce.

Review of Structure of Congress and Relation to Executive Branch

Perhaps the most important characteristic of Congress to understand is that all issues, large and small, are evaluated within the larger, highly complex landscape of national concerns and opinions. The old adage that Congress runs on "politics, policy, and procedure" is important and instructive. Hence, decisions that may seem straightforward from a policy standpoint often become embroiled in political, moral, or ethical debates

[34] American Association for the Advancement of Science, "R&D in the FY 2009 Budget," 2008, available at <http://www.aaas.org/spp/rd/fy09.htm>.

that produce outcomes seemingly tangential to the original problems. In this regard, Congress functions differently than most of the Executive Branch, an aspect that is often confusing to the public and even seasoned observers.

A second important characteristic is that the committee structure in both houses is stovepiped. With almost 60 committees and subcommittees in the Senate, and nearly 90 in the House, stovepiping has critical ramifications for how NSST is managed as a national enterprise. For example, "core" NSST programs are spread across the Armed Services, Foreign Affairs, Energy, and Intelligence committees and subcommittees. With the advent of homeland security as a national security sector, other committees and subcommittees have also come into play. Moreover, both houses divide committee jurisdictions between authorizing committees (handling policy and oversight) and appropriations committees (deciding budgetary allocations). Generally, committee structures are organized to mirror the structure of the Executive Branch. However, committees also exist that handle specific topic areas, e.g., Indian Affairs. This is often confusing to those dealing with Congressional interactions, and sometimes even to Members themselves when attempting to develop legislation or push particular issues. Hence, holistic management of the large NSST enterprise is extremely problematic.

An important problem with regard to NSST management in Congress is cultural. Few Members have technical backgrounds, and few regard S&T as a "tier-one" issue. This lack of perceived importance has many repercussions, including relatively few Members who are willing to be champions for S&T, a dearth of staff with technical backgrounds, and the lesser importance often given to S&T-related legislation.

A final critical issue that should be addressed is the level of technical competence and advice that is available to Congress. One aspect of this problem is at the staff level. For example, it has historically been the case that most NSST issues in both Armed Services committees have been handled by only one or two staffers, who often lack technical backgrounds. Thus, Congress must seek technical advice from outside immediate staff. The problem of the paucity of technical advice in the form and with the timeliness that Congress needs has been a topic of debate for many years.[35] A highly contentious issue in this area was the 1995 abolition of the Office of Technology Assessment (OTA), whose mission was to evaluate the technical, policy, and legislative aspects of S&T. Currently, legislative proposals exist to recreate alternative models for an OTA-like support service, including a pilot project with the Government Accountability Office (GAO).[36]

Problems with Congressional Role in NSST and Recommended Solutions

Four core problem areas regarding Congress's role in NSST are identified and solutions offered in this section. The core problem areas are: the internal structure of Congress, the

[35] For an expansive discussion of these issues, see Granger Morgan and Jon Peha, eds, *Science and Technology Advice for Congress* (Washington, DC: RFF Press, 2003).
[36] For a brief overview of such proposals, see CRS Report RS21586, Genevieve Knezo, "Technology Assessment in Congress," May 20, 2005, available at <http://www.fas.org/sgp/crs/misc/RS21586.pdf>.

interface with the Executive Branch on NSST priorities, setting budgets, and expert advice to Congress.

Internal Organization of Congress

The most important factor that characterizes the functioning of Congress is its committee structure. This structure dictates how public policy problems are defined and parsed, what committee jurisdictions are brought to bear, and which Members actively participate in debate and Congressional action. Fundamentally, Congress's approach to complex problems is reductionist, i.e., it breaks apart problems into policy and topic areas handled by existing or ad hoc committees and subcommittees, each of which then analyzes and suggests action on its piece.

The most important effect of this reductionist approach is the lack of a holistic view of complex policy issues. NSST, and S&T in general, are particularly affected. With the exception of the House Science Committee and two subcommittees of the Senate Commerce committee, both of which manage only a portion of the *domestic* national S&T portfolio, most R&D jurisdiction is buried within broader issue areas. NSST in particular is spread across the Armed Services, Energy, Intelligence, and Homeland Security committees, as well as additional supporting areas, such as space policy. The effects of this fragmentation include difficulties in assessing programmatic overlap or gaps, prioritizing among programs, making informed trade-offs in funding allocations, and, perhaps most importantly, planning effectively at the national level, particularly for the long term.

Four key recommendations that may alleviate at least some of these difficulties include reorganizing committee structures to explicitly include NSST, creating parallel committee structures in the House and Senate, improving coordination among existing committees and members, and raising the importance of NSST and S&T through Congressional leadership.

Although reorganizing the committee structure of Congress is no simple job, the most direct and effective action to raise the importance of NSST and facilitate its effective, holistic management would be to create a committee structure that includes some direct jurisdiction over a broader scope of NSST. Actions to accomplish this could include the creation of subcommittees devoted to NSST in the Armed Services committees. Creating a committee with broader S&T jurisdiction, such as over the Intelligence, Energy, and Homeland Security portfolios, would provide for more effective oversight. A more radical proposal is for the leadership to create several integrative committees focused on key national security S&T policy areas that would have limited authority to propose legislative or budgetary changes to committee actions to approximate holistic management.[37]

[37] For additional discussion of related suggestions for organizational and process changes in Congress see, Cindy Williams and Gordon Adams, "Strengthening Statecraft and Security: Reforming U.S. Planning and Resource Allocation," June 2008, available at <http://www.stimson.org/budgeting/publications/MIT%20mongraph%20Williams-Adams%20final%207.08.pdf>.

One solution to legislative and oversight friction in Congress that has been proposed repeatedly over the years is to create a more parallel committee structure within the House and Senate. Lack of parallelism creates numerous problems, most obvious of which is that as many as five different committees are dragged into policy debates on an issue because of their tangential jurisdiction over a relatively small piece of the issue area. This often results in the engagement of a much larger number of committees, Members, and staff than would seem necessary, with an increase in administrative overhead and confusion. Moreover, oversight actions taken by committees in isolation can send confusing and contradictory messages to the Executive Branch. Parallel committees dealing with NSST in both branches of Congress would vastly improve Senate-House communication and make priority setting and budgeting for NSST much more efficient.

A less radical solution to friction due to the committee structure would be to formally and informally improve the coordination among Members and staff of existing committees handling NSST, and S&T in general. This could be achieved through requiring Members to serve on more than one committee that handles an NSST or S&T area. These Members would then provide informal information flow on the actions and deliberations of other committees and could facilitate joint proposals. To further increase coordination among existing committees and members on key NSST areas, Congress should increase the number of joint hearings by committees that work in related NSST and S&T areas—a rare occurrence today. An April 24, 2008, joint hearing held by the Terrorism, Unconventional Threats and Capabilities Subcommittee of the House Armed Services Committee and the Subcommittee on Research and Science Education of the House Science and Technology Committee on the role of the social and behavioral sciences in national security is a successful example that other Congressional committees should emulate.[38]

To facilitate overall coordination of such overarching NSST areas, the Congressional leadership in both Chambers should provide a more effective impetus. The Leadership should create inter-committee task forces or ad hoc focus groups to periodically address issues of high NSST importance. Leader offices should also dedicate specific staff to focus on NSST issue areas and take a greater role in developing legislative initiatives with broader NSST policy viewpoints. Taking a role in creating holistic and long-term national goals and policy planning in NSST and S&T, and interfacing with the Executive Branch on these issues, is extremely important to Congress's role in the macro-management of the NSST enterprise.

Interface with the Executive Branch

While most detailed NSST policy development and program management occurs in the Executive Branch, Congress plays a critical role in oversight and budget approval. The relationship between the two branches of Government is complex, and their coordination

[38] A copy of the agenda for this joint hearing held by subcommittees of the House Armed Services Committee and the House Science and Technology Committee is available at <http://armedservices.house.gov/hearing_information.shtml>.

on many areas of NSST is weak. One important reason for poor coordination is difference in size, operational style, and culture. For example, the Executive Branch employs thousands of personnel in the NSST enterprise, while an entire department's or agency's S&T portfolio is most often covered by a single staffer on a Congressional authorizing committee.

Other issues more related to operational style or culture also come into play. Because of their oversight function, Congressional Members and staff often find Executive Branch officials reluctant to openly or objectively discuss policy or programmatic details, for fear of adverse Congressional action. Political motivations also come into play when Congress and the Executive Branch are controlled by different parties.

In spite of these difficulties, several steps could be taken to improve the coordination of NSST between the two branches, and also foster a more holistic and long-range planning culture in both. These include the development of a long-range NSST strategy, the creation of a periodic Congressional-Executive NSST policy forum, and improvement of OMB Congressional outreach.

For years, DOD has created long-range, enterprise-level, S&T planning documents, such as the Department of Defense Research and Engineering Strategic Plan and the Naval Science and Technology Strategic Plan. It would behoove Congress to require similar planning documents for the entire NSST enterprise. Most importantly, such documents should be a product of joint Congressional-Executive Branch deliberation and coordination. Committee leadership responsible for NSST areas, along with Executive Branch leadership from the departments and agencies, OMB, and OSTP, should coordinate efforts to create a rolling document that gives multi-year strategic and budgetary guidance across the NSST community, and provides prioritization and evaluation metrics for programs.

An informal mechanism to increase information sharing, debate, and coordination on NSST issues could be the creation of a periodic leadership forum or conference on issues, strategy, and long-range NSST goals, similar to those that have occurred in other NSST areas. Such a conference should be hosted by a non-partisan think tank, and participants could include Members and Executive Branch principals with NSST authority, as well as academics and national security policy professionals. A principal function of such a group would be to help develop the framework for an NSST strategy. As proposed in a report published by the Center for the Study of the Presidency:

> What is needed is the equivalent of an ongoing dialogue. And as we begin the new century, it makes sense to look closely at the Federal government's entire R&D portfolio. The group to do this probably should include representatives from all of the Federal agencies and all of the key Congressional committees. This group would listen to presentations by subject matter experts in health, engineering, defense, energy, and other research areas. This approach would generate a better portfolio sense of what the government currently is doing, and

> provide lawmakers and policy experts with a sense of the direction and pace of how research should be moving.[39]

Finally, OMB could be much more proactive in coordinating interagency processes and in its outreach to and coordination with Congress, which would de-conflict many issues before problems arise. Improved OMB outreach might facilitate the development of the NSST budget and provide Congress with valuable information on programs and priorities when committees are evaluating authorization and appropriations bills.

The Budget Process

Perhaps the most important function that Congress performs each year is passing the annual budget for the United States Government. This process is central to Congress' work, because it drives an extensive debate on the resource and policy priorities for the Nation. Because the size of the budget and of the Federal bureaucracy have increased significantly in recent decades, the budget has become much more complex, while Congressional committee and staff resources have not kept pace, and floor time has increased little. The shortage of staff results in intense time pressure to review spending guidelines and programs, as well as confusion due to the enormous amount of material that must be sifted through. Moreover, many aspects of the budget process are still arcane, reducing the efficiency of Congress even further. The intense time pressure has created a Congress that is largely reactive and focused mostly on the short-term, namely, the passage of that year's budget. Little debate is available for setting long-range goals, or defining multi-year funding strategies. The short-term focus has a particularly negative effect on basic science, which generally requires stable, long-term funding to pursue novel ideas to fruitful scientific outcomes.

One way to reduce the time pressure each year on the budget development process is to lengthen the cycle period, such as going to a two-year Federal budget. With regard to NSST and S&T in general, less drastic but still effective mechanisms can be employed to lengthen the time period between re-authorization of individual programs. Such mechanisms—rolling appropriations, forward funding, up-front funding, and milestone funding—not only reduce the legislative burden on authorizing committees, but put in place stable, multi-year funding for basic research programs.

A major issue in NSST budgeting is that Congress ignores its own rules by allowing appropriations to be passed before programs are actually authorized.[40] Ensuring that programs are authorized before appropriations are passed would force at least a level of technical and policy review of those programs, and would significantly improve the prioritization and resourcing of NSST programs, which are the target of many earmarking requests. Earmarking of programs causes great harm by diverting resources from well planned, high-value NSST programs to low-priority programs. Even when earmarked

[39] Center for the Study of the Presidency, "Advancing Innovation: Improving the S&T Advisory Structure and Policy Process," 2000, 47, available at <http://www.thepresidency.org/pubs/AdvancingInnovation.pdf>.

[40] Paul Jenks, "CongressLine, by GalleryWatch.com: Authorization and Appropriation," January 15, 2007, available online at <http://www.llrx.com/congress/authorization.htm>.

programs come with additional funding, program management and contracting resources are overburdened to execute unplanned programs.[41] In DOD programs, the number of Congressional earmarks rose by a factor of five from 1994 to 2005. [42] For FY08, Congress earmarked $3.5 billion in DOD R&D projects, most of which ($2.2 billion) would go to S&T projects.[43]

Expert Advice to Congress

One of the most important underlying factors in Congress for budget development, oversight, and policy decisionmaking is the availability of expert, objective advice to Members and staff. This issue cuts across all public policy areas and is almost as old as Congress itself. It has been particularly crucial in the S&T arena, because of the general obscurity of the subject matter to the public and most Members, and its increasing relevance to all policy areas. It is even more crucial in the NSST realm, because NSST encompasses such a large fraction of our nation's overall S&T efforts.

Expert advice to Congress on S&T has been a long-standing and sometimes contentious issue, with considerable debate ongoing. Although the resources required for this activity are not particularly large, there is considerable misunderstanding about the form such expert advice should take. Technical advice to Congress must be objective, non-partisan, and provided in a form and with the timeliness Congress requires to make practical use of it. For example, technical advice is most useful to Members when it is succinct and accompanied by a sense of the policy framework, political considerations, and even legislative activities that bear on it.

Based on our research, most Congressional Members and staff believe that they have insufficient technical literacy to understand the nuances of many S&T-related issues and few resources that can provide information of practical use to them. Tools are needed to ensure that important national security policymakers are better informed of key S&T issues. Two key recommendations that may serve to improve accessibility of S&T advice to Congress include creating an OTA-like organization and an NSST caucus.

The Congressional support agencies (Congressional Research Service, Congressional Budget Office, and Government Accountability Office) provide expert advice to Congress on different policy areas and in different formats. Until September 29, 1995, when it was closed, OTA was a fourth agency specifically focused on S&T and related policy, and was also important in analyzing the NSST foundations of major defense policy issues. OTA was dissolved by Congress for several stated reasons, one of which

[41] Inspector General United States Department of Defense, "The Cost, Oversight and Impact of Congressional Earmarks Less Than $15 Million," Report No. D-2008-110, August 8, 2008, available online at <http://www.dodig.osd.mil/Audit/reports/fy08/08-110.pdf>.

[42] Congressional Research Service, "Earmarks in Appropriation Acts: FY 1994, FY 1996, FY 1998, FY 2000, FY 2002, FY2004, FY2005," January 26, 2006, available at <http://www.fas.org/blog/secrecy/2006/02/crs_on_appropriation_earmarks.html>.

[43] American Association for the Advancement of Science, "R&D Earmarks Total $4.5 Billion in 2008," January 7, 2008, available at <http://www.aaas.org/spp/rd/fy09.htm>.

was that it did not provide Congress with timely advice.[44] Several legislative proposals exist to reestablish some version of OTA, and the GAO has an internal pilot project to provide OTA-like analyses.[45] Such an organization would provide Congress with much-needed and expertly informed information that is key to NSST policymaking.

Congressional caucuses are an informal mechanism for knowledge sharing, discussion, and networking on particular policy or focus areas. Congress has an S&T caucus and an R&D caucus, as well as several other S&T-oriented groups. Creating a focused NSST caucus would be a major step toward a forum for the integrated NSST community and issues they share, and the stakeholders involved. An NSST caucus would provide a critical forum for debating priorities and resources necessary to assure a strong, interagency NSST enterprise to meet the requirements of U.S. national security strategy.

The implementation of recommended reforms to Congressional structure and processes discussed in this section will provide for significant improvement in the prioritization of, resources for, and delivery of NSST that will result in cost-effective and timely technical solutions to national security problems. The result will be a significant improvement in the national security of the United States.

[44] David Malakoff, "U.S. Science Policy: Memo to Congress: Get Better Advice," *Science*, June 22, 2001, 292, no. 5525, 2229–2230, available at <http://www.sciencemag.org/cgi/content/full/292/5525/2229b>.
[45] Audrey T. Leath, "Is Congress Getting the S&T Analysis It Needs?," *FYI*, The American Institute of Physics Bulletin of Science Policy News, No. 106, August 28, 2006, available at <http://www.aps.org/units/fps/newsletters/2006/october/news.html>.

Government's Science and Engineering Workforce

The preceding two sections have focused on national security policy, strategy, senior political appointments, and structural and interface issues related to Congress' role in national security. These are perpetually dynamic issues having time scales of only a few years. Science and technology, however, operate on much longer time scales, and their management requires stability over these longer time scales. The permanent professional staff of the Federal science and engineering (S&E) workforce plays a key role in contributing to the needed stability.

This section addresses two issues regarding the Federal S&E workforce that relate to how well the U.S. Government's interagency processes serve security interests on S&T matters. First, there has been a general perception since the 1980s that the stature and competence of Government scientists and engineers (S&Es) is in decline. If true, the decline is important, because S&Es play a necessary and key role in interagency decisionmaking on matters involving S&T.

Second, the role of the Federal S&E workforce in ensuring accountability for the performance of public functions and the use of public funds is essential—but outsourcing policies have diminished it. Ultimately, the decisions concerning the types of S&T work to be undertaken, when, by whom, and at what cost, *must be made by Government officials responsible to the President and to the Congress*. Moreover, those officials must be competent and empowered to supervise the work and evaluate its results. Technologies and systems that are ineffective for the mission, over-budget, and behind schedule degrade the ability of interagency processes to solve national security problems.

Workforce Stature and Competence

Functions of the Federal S&E Workforce

Interagency panels draw strongly upon the skills provided by Government S&Es. For example, one mission of the State Department is to advise exporters as to whether an item is subject to controls mandated by the U.S. Munitions List. Through an extensive interagency "commodity jurisdiction" process, the State Department receives technical assessments from S&Es within the Departments of Defense, Commerce, and Energy. It then uses the assessments to make export control decisions.[46]

Interagency decisions to export, or not to export, U.S. technology can have enormous implications for the increasingly complicated interplay between the interests of national security and economic competitiveness. The stakes are high. For instance, the latest "High Tech Indicators" study predicts that, although China is often seen as just a low-

[46] U.S. Department of State, "Review of the U.S. Munitions List and the Commodity Jurisdiction Process," Memorandum Report 01-FP-M-027, March 2001.

cost producer of manufactured goods, it is taking major steps that may enable it in the next 20 years to rival the United States in the critical ability to develop basic science and technology, turn those developments into products and services, and then market them to the world.[47]

Another example of how Government S&Es participate in interagency decisionmaking is their strong involvement in the many projects of the National Science and Technology Council (NSTC), including studies on such national-level issues, concerns, and threats as the environment, terrorism, health, disaster reduction, water availability, bio-engineering, cyber-security and information assurance, food safety, nanotechnology, and aeronautics.[48]

But in as much as Government S&Es are vital to interagency processes, no mission is as important as their fundamental one—to provide objective and authoritative technical advice on contract R&D programs to Federal decisionmakers. Most Federal R&D funds are expended on contract. Decisions on what contracts to enter and oversight of the funded work often involve complex scientific and technical issues. *The advice provided by government S&Es must be technically authoritative, knowledgeable of mission requirements, and accountable to the public interest*. In fact, the ability to meet this primary responsibility provides the basis for the effective participation of Government S&Es in any interagency process.

The important nature of the responsibility of Government S&Es was summed up well in a 1980 report endorsed by Dr. William Perry (then Undersecretary of Defense for Research and Engineering and later Secretary of Defense). It declared that the Government "requires internal technical capability of sufficient breadth, depth, and continuity to assure that the public interest is served."[49]

This "internal technical capability" consists of a core of S&Es, many of them performers of R&D, who should be distinguished from the much larger acquisition workforce. These S&Es provide authoritative advice and state-of-the-art expertise to the acquisition workforce, which is responsible for successfully managing procurement in a way that meets public purposes. The two communities serve a common purpose but operate within different environments and with different objectives, requirements, and skills.

Civil Service Constraints

The Federal Government's internal scientific and technical capability is necessary to meeting interagency requirements in the area of national security. This internal capability resides principally in the Federal Government's laboratories. Since the mid-1980s,

[47]Georgia Institute of Technology, "Press Release: High Tech Indicators: Technology-based Competitiveness of 33 Nations—2007 Report," January 24, 2008.
[48] National Science and Technology Council, "NSTC Reports," available at <http://www.ostp.gov/cs/nstc/documents_reports>.
[49] William J. Perry, *Required In-House Capabilities for Department of Defense Research, Development, Test and Evaluation* (Washington, DC: Department of Defense, 1980).

growing concerns have been expressed about the continued ability of the Government S&E workforce to meet its missions. A White House-level study (the "Packard Report") stated in 1983 that:

> Almost all of the Federal laboratories suffer serious disadvantages in their inabilities to attract, retain, and motivate scientific and technical personnel required to fulfill their missions … actions should be initiated now to create, at government-operated laboratories, a scientific/technical personnel system independent of current Civil Service personnel systems.[50]

Over the years since the Packard Report, numerous studies have recognized the Civil Service system's inherent constraints on recruiting and retaining technical personnel, and have made similar, if not the same, proposals for reform.

Studies since the Packard Report include: the Defense Science Board's "Report of the 1987 Summer Study on Technology Base Management" (1987); the National Commission on the Public Service's "Leadership for America: Rebuilding the Public Service" (1989); OTA's "Holding the Edge: Maintaining the Defense Technology Base" (1989); the National Academy of Public Administration's "Civilian Workforce 2020" (2000); and the National Commission on the Public Service's "Urgent Business for America: Revitalizing the Federal Government for the 21st Century" (2003).

One key recommendation for reform, made by the National Commission on the Public Service, calls for dividing the current Senior Executive Service (SES) into an Executive Management Corps (EMC) and a separate Professional and Technical Corps (PTC).[51] The report elaborates that:

> [t]he EMC should be separated from the PTC for purposes of recruiting, compensation, assignment, and effective utilization. In general, we believe that compensation for members of the EMC will be similar across the government, while compensation for technical and scientific specialists would vary much more in response to differences in individual labor markets.[52]

Because the SES is the main route for senior employee advancement, many members of the SES are not managers, but are instead scientists, engineers, and technical specialists. This reform would address that issue and allow a more appropriate and effective way of managing the Government's scientific and engineering talent.

Government S&E Workforce—Today

It is remarkable that, despite civil service system constraints, today's Government S&Es measure well against their non-Federal peer groups. This point is made by the following

[50] *Report of the White House Science Council*, 1983, available at <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA323669&Location=U2&doc=GetTRDoc.pdf>.
[51] Report of the National Commission on the Public Service, "Urgent Business for America: Revitalizing the Federal Government for the 21st Century," (January 2003), 20–21.
[52] Ibid.

tables, which provide comparisons among Government S&Es and similarly situated non-government S&Es.[53]

Table 1 provides data on memberships in the three national academies held by the R&D organizations. Table 2 provides data regarding peer-reviewed open literature publications. Both indicate that the institutions staffed by Government S&Es (NIH, NIST, and NRL) account for themselves quite well, by these two metrics. While NIH, NIST, and NRL may not be typical of all public-sector institutions, they do prove the point that, under proper circumstances, the Government can still attract the very best S&E talent.[54]

Table 1. National Academy Membership (Source: National Academies Website)

	ANL	BNL	JPL	LANL	LL	LLNL	IBM	NIH	NIST	NRL
National Academy of Engineering	3	2	6	4	1	3	17	0	10	5
National Academy of Sciences	3	9	0	5	0	0	11	50	5	3
Institute of Medicine	0	0	0	0	0	0	0	87	0	0
Total	6	11	6	9	1	3	28	137	15	8

Table 2. Peer-Reviewed Publications 2003 (Source: Science Citation Index Search)

ORGANIZATION	ANL	BNL	JPL	LANL	LLNL	NIH	NIST	NRL
Articles	1023	761	705	1526	1038	4305	350	957

Government S&E Workforce—Tomorrow

With the significant exception of the new flexibilities used by the Government's innovative personnel demonstration projects, the high-level calls for personnel system reform have gone largely unheeded. This is risky, given national S&T trends and the changing world environment. The disturbing facts listed below were noted in *Rising Above the Gathering Storm*:[55]

[53] Tables taken from Timothy Coffey, "Building the S&E Workforce for 2040: Challenges Facing the Department of Defense," *Defense & Technology Paper* 49, (Washington, DC: Center for Technology and National Security Policy, July 2008), available at <http://www.ndu.edu/ctnsp/Def_Tech/DTP%2049%20BuildingtheS&EWorkforcefor2040.pdf>.

[54] The three Federally staffed institutions are the National Institutes of Health (NIH), the National Institute of Standards and Technology (NIST), and the Naval Research Laboratory (NRL). These organizations represent three separate Departments of the Executive Branch. The other institutions are Argonne National Laboratory (ANL), Brookhaven National Laboratory (BNL), Jet Propulsion Laboratory (JPL), Lincoln Laboratory (LL), Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL) and IBM Watson and Almaden Laboratories (IBM). The National laboratories were chosen because their missions are similar to the three Federal laboratories, but they are not staffed by Government employees. The IBM laboratories have been selected because of their high standing within the scientific and technology community. Most of the institutions considered are comparable in size (within a factor of two), except NIH, which is much larger than the others.

[55] Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, National Academy of Sciences, National Academy of Engineering, and Institute of

- There were almost twice as many U.S. physics bachelor of science degrees awarded in 1956, the last graduating class before Sputnik, as in 2004.
- In South Korea, 38 percent of all undergraduates receive their degrees in natural science or engineering. In France, the figure is 47 percent, in China, 50 percent, in Singapore 67 percent, and in the United States, 15 percent.
- Some 34 percent of doctoral degrees in natural sciences (including the physical, biological, earth, ocean, and atmospheric sciences) and 56 percent of engineering PhDs in the United States are awarded to foreign-born students.
- In the American S&T workforce in 2000, 38 percent of PhDs were foreign-born.

In addition, the Government is facing a large-scale exodus from its workforce. According to the Office of Personnel Management, more Federal employees are expected to retire in 2008 than in any previous year, and, by 2012, more than 50 percent of the current work force, including 90 percent of senior management and one-third of all scientists and economists, will have retired—leaving a quarter million jobs to fill.[56]

These trends mean that the Federal Government will compete for technical talent at the same time that the nation's S&E workforce is shrinking and the competition posed by foreign nations is increasing. A 2001 report issued by the U.S. Commission on National Security/21st Century, commonly known as the "Hart-Rudman Report," discussed the shrinking American S&E workforce:

> Second only to a weapon of mass destruction detonating in an American city, we can think of nothing more dangerous than a failure to manage properly science, technology, and education for the common good over the next quarter-century.[57]

There are simply fewer American-citizen graduates with high-technology credentials and the eligibility (primarily security clearances) to work on national security problems. In 2004, the National Defense Industrial Association (NDIA) found that almost 9 percent of all funded S&E positions in the defense and aerospace workforce were unfilled due to a lack of qualified candidates, with the situation getting worse.[58]

Unfortunately, these worrisome trends have not compelled sustained and broad-based action, even in the arena of national security. In fact, the U.S. Comptroller General recently stated that DOD "did not have a comprehensive plan to ensure its workforce had the right skills and capabilities to manage and assess contractor performance."[59]

Medicine, *Rising Above The Gathering Storm: Energizing and Employing America for a Brighter Economic Future* (Washington, DC: National Academies Press, 2007).

[56] Tony Dokoupil, "C'mon and be a Bureaucrat," Newsweek, March 1, 2008.

[57] Commission on National Security/21st Century, *Road Map for National Security: Imperative for Change* (Washington, DC: Government Printing Office, 2001), 30.

[58] "Industry, DoD Strategize to Avert Workforce Crisis," InsideDefense.com, Defense Alert, December 23, 2004; National Defense Industrial Association, "Industry Position on Critical Workforce Skills," Quick-Look Report, June 10, 2004.

[59] Hon. David M. Walker, "DoD Transformation: Challenges and Opportunities," briefing given at Fort McNair, Washington, DC, November 29, 2007.

Without a strong S&E workforce, the United States faces a number of negative consequences, including the loss of international, business, and economic leadership. As discussed in a 2003 National Academy report, "If the S&E workforce is inadequate to need, the nation's innovation engine will slow, curtailing U.S. competitiveness in a global economy that is revving up with unprecedented vigor."[60]

One action that will minimize the impact of decreasing S&E positions on laboratories is to grant authority for direct appointment without competition for those S&E positions that perform S&T. This authority would enable laboratories to make immediate offers for positions for which candidates are few and in high demand, shortening the hiring process by weeks. Because the laboratories recruit for such highly specialized skills, they do not have the large numbers of applicants for which competitive recruitment rules make sense.

Further, a study should be performed by an organization of similar stature to the National Commission on the Public Service, to focus on additional ways to preserve the technical competence and capabilities of the Government's S&E workforce.

Preserving Technical Competence

The good news is that the Federal Government has taken a strong, proactive step toward preserving its in-house technical competence by implementing new flexibilities within its innovative personnel demonstration projects, which were authorized by the Civil Service Reform Act in 1978.

In 1988, the Commerce Department established a demonstration project at NIST. And between 1997 and 2002, DOD implemented projects at eight of its laboratories. Together, these projects encompass more than 42,000 employees, most of them S&Es.[61] In addition, a *Federal Register* notice was recently approved for a new demonstration project at the Department of Energy's National Nuclear Security Administration.[62]

In 1996, the NIST project was extended indefinitely.[63] But DOD's eight laboratory demonstration projects will only continue to operate until 2011, at which time DOD will decide whether to extend them or pull their S&E workforces into the department-wide National Security Personnel System (NSPS).[64] The latter course is not recommended. Assimilating them into NSPS risks damage to the laboratories' ability to compete in a highly competitive marketplace for scientific and engineering talent. This is because NSPS is structured to address non-S&T activities that are by nature more predictable and have nearer-term objectives. As a system designed to manage more than 700,000

[60] Shirley Ann Jackson, National Academy of Sciences, National Academy of Engineering, Institute of Medicine, *Envisioning a 21st Century Science and Engineering Workforce for the United States: Tasks for University, Industry, and Government* (Washington, DC: National Academies Press, 2003), 5.
[61] Office of Personnel Management, "Alternative Personnel Systems in the Federal Government: A Status Report on Demonstration Projects and Other Performance-Based Pay Systems," December 2007, 6.
[62] Ibid., 8.
[63] P.L. 104-113, Section 10.
[64] Ibid., 14.

employees, NSPS is understandably a less flexible and adaptive system than what is required by more dynamic, and often unique, S&T requirements.

As was done for the NIST project, DOD should permanently implement the eight DOD laboratory demonstration projects and empower them to pioneer additional concepts in personnel management for the Department, using all authorities granted by the U.S. Congress, such as those contained in Section 1114 of the National Defense Authorization Act for Fiscal Year 01.

Role of the Federal S&T Workforce

Accountability for Public Missions and Expenditures

The U.S. Government is ultimately responsible and accountable for national missions and public expenditures. Therefore, decisions concerning the types of S&T work to be undertaken, when, by whom, and at what cost, must be made by Federal officials responsible to the President and the Congress. These officials must also be able to supervise the work and evaluate its results. Such functions are essential to the success of intra-agency missions and decisionmaking. In fact, technologies and systems that are ineffective for the mission, over-budget, and behind schedule degrade the ability of the Government to solve national security problems.

To perform these critical functions, the Federal Government has traditionally maintained within its own laboratories a highly competent cadre of scientists and engineers who act as trusted advisors, in sufficient numbers, and with sufficient stature to adjudicate among the often-conflicting S&T advice and proposals from the larger community. Put another way, the need for profit makes each company a compelling advocate of its own product. Given that natural tendency, the Government requires independent and authoritative technical advice to use as what political scientist Harold Nieburg called a "yardstick."[65]

Because there is no knowing without doing, some of the in-house workforce must be capable of performing state-of-the-art R&D. Dr. Wernher von Braun, space pioneer and director of the Marshall Space Flight Center, described this requirement in the following way.

> In order for us to use the very best judgment possible in spending the taxpayer's money intelligently, we just have to do a certain amount of this research and development work ourselves … otherwise, our own ability to establish standards and to evaluate the proposals—and later the performance—of contractors would not be up to par.[66]

[65] Harold L. Nieburg, *In the Name of Science* (Chicago: Quadrangle Books, 1966).
[66] Wernher von Braun, Sixteenth National Conference on the Management of Research, September 18, 1962.

An Emerging Accountability Gap

The Federal S&E workforce worked well in this role for many years and helped the United States to maintain an edge over adversaries by fielding technologically superior warfighting systems. In fact, many of today's most important military technologies can be traced back to the work of Government laboratories—the first modern radar, the first intelligence satellite, the Sidewinder missile, stealth technologies, the Global Positioning System, the hyperbaric bomb, and many others.

However, future success is in doubt. An increasing number of new weapon systems are experiencing serious technical difficulties, many of which should have been anticipated before the programs were approved. For example, in its study on the prospects for countering improvised explosive devices, the National Academy of Sciences found it necessary to state: "The desire to meet the challenges of detection must be grounded in the fundamental physical and chemical limits of detection and take into account reasonable extrapolations of existing technology."[67] Of the 72 DOD weapons programs that GAO assessed recently, none had proceeded through system development meeting the best practices standards for mature technologies or stable design.[68]

A scientific and technical accountability gap has emerged that poses great difficulties for intra-agency missions and interagency national security initiatives. The Federal Government is not maintaining adequate and appropriate technical competence, or is not making proper use of the competence that it has maintained. Inappropriate types and unhealthy cumulative levels of outsourcing have driven these trends. A GAO report states:

> The closer contractor services come to supporting inherently governmental functions, the greater the risk of their influencing the government's control over and accountability for decisions that may be based, in part, on contractor work. This may result in decisions that are not in the best interest of the government.[69]

To be clear, the Federal Government can, and as appropriate should, outsource S&T work to meet its missions and fulfill its obligations to the American people. The *merit* of outsourcing is not the issue; instead, the issues are its *appropriateness* and its potential for adversely impacting the maintenance of sufficient competence internal to the Government.

Past Problems Sparked Reform

In July 1961, in the wake of Federal contracting abuses in the 1950s, President John F. Kennedy charged a high-level study team, led by David E. Bell, the Director of the

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[67] National Academy of Sciences, Committee on Defeating Improvised Explosive Devices: Basic Research to Interrupt the IED Delivery Chain, *Countering the Threat of Improvised Explosive Devices* (Washington, DC: National Academies Press, 2007).

[68] GAO, "Defense Acquisition: Assessments of Selected Weapon Programs," GAO-08-467SP, March 2008.

[69] GAO, "Department of Homeland Security: Improved Assessment and Oversight Needed to Manage Risk of Contracting for Selected Services," GAO-07-990, September 17, 2007, 6.

Bureau of the Budget (now the Office of Management and Budget), with developing policies that would subject military contractors to more effective control by public authority.[70] In 1962, Bell submitted his team's report to President Kennedy. It found, inter alia, that:

> … *decisions concerning the types of work to be undertaken, when, by whom, and at what cost … must be made by full-time Government officials clearly responsible to the President and to the Congress.* Furthermore, such officials must be in a position to supervise the execution of work undertaken, and to evaluate the results. *These are basic functions of management which cannot be transferred to any contractor if we are to have proper accountability for the performance of public functions and for the use of public funds.*
>
> … we need to be particularly sensitive to the cumulative effects of contracting out Government work. A series of actions to contract out important activities, each wholly justified when considered on its own merits, may when taken together begin to erode the Government's ability to manage its research and development programs. There must be a high degree of awareness of this danger on the part of all government officials concerned.
>
> … *No matter how heavily the Government relies on private contracting, it should never lose a strong internal competence in research and development* (emphasis added).[71]

The Bell Report had a big impact. The Salary Reform Act of 1962 moderately improved salary scales at the upper levels of the Federal workforce[72] and authorized allocation of Civil Service grades 16–18 to positions primarily concerned with R&D. This authority set no numerical limitations.[73] In addition, support from the Civil Service Commission yielded process changes, such as the ability to appoint exceptionally qualified individuals to steps above the minimum entrance step in grades GS-13 and up, without the Commission's approval.[74] The study also forced change in areas other than personnel management. The authority to perform security reviews of scientific papers was delegated to the laboratory level.[75] More discretionary research funding was provided. Construction funds for new and upgraded facilities were increased considerably.

The combined effect of these and other reforms allowed the laboratories to "become more competitive in recruitment" and yielded "significant improvement in their ability to

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[70] Panel members included, in addition to the Director of the Bureau of the Budget, the Secretary of Defense, the Chairman of the Atomic Energy Commission, the Chairman of the U.S. Civil Service Commission, the Administrator of the National Aeronautics and Space Administration, the Director of the National Science Foundation, and the special assistant to the President for science and technology.

[71] "Report to the President of the United States on Government Contracting for Research and Development," April 1962, 18–19, 22, 46,

[72] Nieburg, 344–345.

[73] In 1963, the Navy had 158 R&D professionals at the GS-16 level. By 1970 there were 249, with another 14 at the GS-17 level and 2 at the GS-18 level. Booz-Allen & Hamilton, Inc., *Review of Navy R&D Management: 1946–1973*, June 1, 1976, 144.

[74] Nieburg, 345.

[75] Office of the Director of Defense Research and Engineering, *Report of the Task Group on Defense In-House Labs*, ("Glass Report"), May 25, 1971, 16.

attract first-class people to leadership positions."[76] It should be noted that these reforms were not born of an uncritical affection for Government infrastructure. At the same time, DOD concluded that the large base structure developed during World War II and the Korean conflict was no longer necessary. Hundreds of base closures and realignments took place during the 1960s, including some laboratories; more than 60 major bases were closed.[77]

In short, DOD proved it was possible to nurture a high-quality workforce and cut infrastructure at the same time.

Today's Problems

Over the last two decades or so, Federal agencies have increased their levels of contracting as they downsized their internal workforces. The military in particular began to shift its acquisition responsibility to the private sector in the mid-1990s to "reinvent government" and cut costs. Expecting that programs could be run more effectively and efficiently by the private sector, DOD cut its acquisition workforce by more than 50 percent between 1994 and 2005.[78]

With a smaller in-house workforce and an increasing workload, particularly after the September 11, 2001, terrorist attacks, some agencies turned to lead systems integrators (LSIs). An LSI is a contractor, or team of contractors, hired by the Federal Government to execute a large, complex, acquisition program. LSIs may perform some or all of the following functions: requirements generation; technology development; source selection; construction or modification; procurement of systems or components from, and management of, supplier firms; testing; validation; and administration.[79] Some of these functions have traditionally been considered to be "inherently governmental."

In particular, requirements generation and source selection are functions that strongly define the mission, scope, and direction of a major Government program. As mentioned above, the Bell Report stated that decisions concerning "the types of work to be undertaken, when, by whom, and at what cost … must be made by full-time Government officials clearly responsible to the President and to the Congress."

The LSI approach gave industry unprecedented authority to develop complex new weapon systems, many of which have experienced serious problems:

- Army's $234 billion *Future Combat System* (FCS). The LSI is a partnership between Boeing and Science Applications International Corporation (SAIC). Costs have more than doubled from $92 billion in 2003, and the program is years

[76] Glass Report, 22–23.
[77] Defense Base Closure and Realignment Commission, *1995 Report to the President*, July 1, 1995, 4-1.
[78] Congressional Research Service, "Defense Acquisition: Use of Lead Systems Integrators (LSIs)—Background, Oversight Issues, and Options for Congress," March 26, 2007, 3.
[79] Ibid., 2.

behind schedule.[80] Moreover, the list of equipment to be acquired has been reduced for lack of technological feasibility, affordability, or both.

- Coast Guard's $24 billion *Integrated Deepwater Systems* program. The LSI is Integrated Coast Guard Systems (ICGS), a joint venture between Northrop Grumman and Lockheed Martin. After five years, the program has produced eight patrol boats that failed seaworthiness tests and a cutter that is behind schedule, over budget, and with possible design flaws.[81]

- DOD's $53 billion *National Missile Defense* System. The LSI is Boeing. In 2004 the GAO found that decisionmakers in DOD and Congress did not have a full understanding of the overall cost of developing and fielding the system and what its true capabilities will be.[82]

- Air Force's $15–25 billion *Transformational Communications Satellite*. The LSI is Booz-Allen-Hamilton. After falling three years behind schedule and running $500 million over budget, the system is making a comeback.[83]

- Navy's $1 billion *Littoral Combat Ship* (LCS)–Flight 0. The program competes two LSIs, General Dynamics and Lockheed Martin. Costs for two lead ships more than doubled, and three ships were dropped from procurement. The program did not have an executable business case (i.e., it was based on a commercial ferry design) or realistic cost estimates, which led to higher costs, schedule delays, and quality problems.[84]

- Navy's $6.1 billion *VH-71 Presidential Helicopter*. The LSI is Lockheed Martin. The helicopter, designed to be an "Oval Office in the Sky," is 1,200 pounds overweight and $600 million over its development budget.[85]

- Department of Homeland Security's $20 million *Project 28*. The LSI is Boeing. The 28-mile "virtual fence" along the Arizona-Mexico border was accepted by DHS in February 2008. Less than a week later, GAO reported that it "did not fully meet agency expectations."[86] In April, DHS announced it was replacing the fence with new towers, radars, cameras, and computer software because it does not work properly.[87]

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[80] William Mathews, "The End of LSIs?," *Defense News*, May 28, 2007, 1; and "An End to Lead Systems Integrators," *Defense News*, December 10, 2007, 1.
[81] Ibid., 8.
[82] Government Accountability Office, "Missile Defense: Actions Are Needed to Enhance Testing and Accountability," GAO-04-409, April 2004.
[83] Mathews, "The End of LSIs?," 1.
[84] Government Accountability Office, "Defense Acquisitions: Realistic Business Cases Needed to Execute Navy Shipbuilding Programs," GAO-07-943T, July 24, 2007, 3, 10.
[85] Mathews, "The End of LSIs?," 1
[86] Government Accountability Office, "Homeland Security: DHS Has Taken Actions to Strengthen Border Security Programs and Operations, but Challenges Remain," GAO-08-542T, March 6, 2008, 13.
[87] GovernmentExecutive.com, *CongressDaily*, April 23, 2008, available at <http://www.govexec.com/dailyfed/0408/042308cdam2.htm>.

LSI Approach Criticized

The problems inherent in the LSI approach were not unforeseen. In 2002, a year before the Army contracted with an LSI for the FCS program, the National Defense University Center for Technology and National Security Policy (CTNSP) was briefed on the Army plans. The study team reported that it was "not comfortable with an approach that turns this much control over to the private sector" and referred to the Bell Report's warning that there must be sufficient technical expertise within the Government that outside technical advice does not become de facto technical decisionmaking.[88]

Similar criticisms have been made subsequently by the Government customers as the price tags for new systems grew and programs fell behind schedule. For example, in the wake of the problems with both *Deepwater* and the *Littoral Combat Ship*, Coast Guard Commandant Admiral Thad Allen and Secretary of the Navy Donald Winter stated respectively that,

> We've relied too much on contractors to do the work of government as a result of tightening budgets, a dearth of contracting expertise in the Federal government, and a loss of focus on the critical governmental roles and responsibilities in the management and oversight of acquisition programs.[89]
>
> The lead systems integrator should be the Navy—not the contractor.[90]

Finally, a recent review by the Institute for Foreign Policy Analysis noted that, "[i]ncreasingly, Pentagon leadership is losing its ability to tell the difference between sound and unsound decisions on innovative technology and is outsourcing key decisionmaking as well." The review further noted that in 1974 over half of those managing the acquisition of Air Force systems held engineering degrees, while in 2001 that percentage had dropped to 14 percent.

Reestablishing Government's Responsibilities

In 2008, the U.S. Congress stepped in and banned the use of LSIs after October 1, 2010. The law further stipulates that:

> The Secretary of Defense shall ensure that the acquisition workforce is of the appropriate size and skill level necessary—(A) to accomplish inherently governmental functions related to acquisition of major systems; and (B) to effectuate the purpose of subsection (a) to minimize and eventually eliminate the use of contractors to perform lead systems integrator functions. [Public Law 110-181, Section 802]

Examining assumptions would also help to reestablish the Government's responsibilities. For example, too often the problems that plague large acquisitions are assumed to be the

[88] National Defense University/Center for Technology and National Security Policy, "Section 913 Report #2: Information Science and Technology and the Department of Defense Laboratories," July 2002, v.
[89] John T. Bennett, "U.S. Reasserts Control Over Contractors," *Defense News*, April 23, 2007, 8.
[90] Ibid.

result of bad management.[91] Sometimes they are, but often they are the result of bad technical decisionmaking by the Government (i.e., it should have never started the program in the first place, should have taken a different approach, etc.). *Better cost estimating will not rectify bad technical decisions*. Another source of the current problems has been the assumption that the Government needs only the acquisition workforce, not the internal S&E workforce. A recent review of acquisition reform states;

> One need only examine the history of three of DoD's largest and most controversial programs over the past 20-plus years to further reinforce the fact that undertaking major developments without understanding key technical issues is the root cause of major cost and schedule problems.[92]

Given similarities between today's environment and that of the early 1960s with regard to the question of what is "inherently governmental," the next Administration should commission a 2009 version of the 1962 Bell study—with the same degree of seriousness and high-level attention. The interagency panel should:

- Propose the means for ensuring a Government acquisition workforce of the appropriate size and skill necessary to accomplish inherently governmental functions,
- Develop policies that would subject national security contractors to more effective control by public authority, and
- Propose a strategy by which the Government would develop and maintain the world-class Federal S&E workforce needed to accomplish the above.

[91] Charlie Savage, "Senator Warns of a 'Crisis' in Pentagon Cost Overruns," *New York Times*, June 4, 2008.
[92] Thomas Christie, "Questioning Acquisition Reform," *Proceedings*, March 8, 2006, available at <http://ww.military.com/forums/0,1524,90349,00.htm>.

Conclusion and Recommendations

A strong NSST enterprise across Federal agencies is essential to providing for the defense of the Nation and assuring the security of the homeland. A critical examination of the essential elements and processes within the Government for setting national security S&T priorities, providing the resources needed to support those priorities, and assuring an adequate and properly utilized Federal NSST S&E workforce is the focus of this report. Suggested changes to structures, processes, and functions that are critical to assuring the strength of the essential NSST enterprise are embodied in the following key recommendations for the Executive Branch, the Congress, and the Federal S&E workforce.

Executive Branch Reforms

- Rapidly fill the positions of Science Advisor to the President and Director of the Office of Science and Technology Policy and accelerate the appointment of the senior scientific advisors in the departments and agencies.
- Fill all four OSTP Associate Director Positions and assign them to joint positions in key Executive Office components, such as OMB, NSC, HSC and NEC.
- Develop with Congress a National Security Science and Technology Strategy and use it to set priorities for NSST and to direct agency resourcing and implementation.

Congressional Reforms

- Reorganize Congressional committees to explicitly include NSST and to create parallel committees in the House and Senate.
- Create inter-committee task forces to develop a long-range NSST Strategy (with the Executive Branch) and address issues of high importance to NSST.
- Create a standing Congressional–Executive NSST Forum to address NSST issues, including working budgets with OMB.
- Ensure that programs are authorized before appropriations are approved to provide technical review and reduce the deleterious impacts of earmarking.
- Improve Congress's access to good technical advice by creating an OTA–like organization as well as an NSST caucus.

Government Science and Engineering Workforce Reforms

- Divide the Senior Executive Service into an Executive Management Corps and a separate Professional and Technical Corps.
- Provide for "direct appointment without competition" authority for NSST positions.

- Permanently implement the eight DOD laboratory demonstration projects using all the authorities contained in Section 1114 of the NDAA for FY 01.
- Institute incentives to preserve the technical competence and capabilities of the Government's NSST S&E workforce.
- Create an interagency team, similar to the one that conducted the 1962 Bell study to determine what is "inherently governmental" and the consequent roles of the government's NSST S&E workforce.

Implementing these recommendations will greatly improve the ability of the NSST enterprise that works across Government to contribute to, access, and utilize science and technology to promote informed decisions and develop effective policies to enhance our national security. These recommendations need to be implemented early in the new Administration.